



The Use of Multiple Technology
Measurements to Diagnose Weapon
Chamber Pressure Measurement
Anomalies in Piezo-Electric
Pressure Transducers

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Vital Importance of Chamber Pressure Measurement to US Army Weapons Development

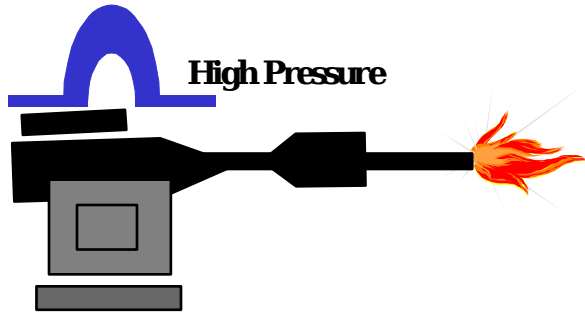
- Used for critical decisions between crew safety and combat effectiveness
- A 2% error causes:
 - 6% change in fatigue life
 - 4% change in range
 - 3% change in weight
- It is currently the most demanding voltage amplitude measurement made with ballistic instrumentation



Technical Objectives

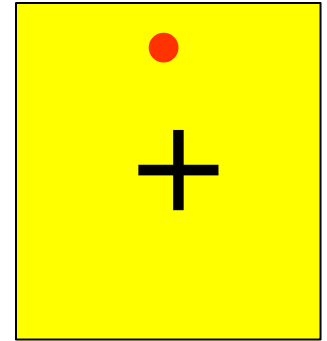
- LONG TERM GOAL: IMPROVE CHAMBER PRESSURE MEASUREMENT ACCURACY BY A FACTOR OF 20X (FROM $\pm 2\%$ TO $\pm 0.1\%$) i.e. MAKE PRESSURE AS CONSISTENT AS VELOCITY
- SHORT TERM GOAL: MAKE EFFECT OF 65 GRAM CHANGE IN 8.6 Kg CHARGE WEIGHT (AS DONE IN PROPELLANT ASSESSMENT TESTING) MORE SIGNIFICANT THAN THE EFFECT OF EXCHANGING TRANSDUCERS (BOTH ABOUT 1%)

BALLISTIC CORRECTIONS

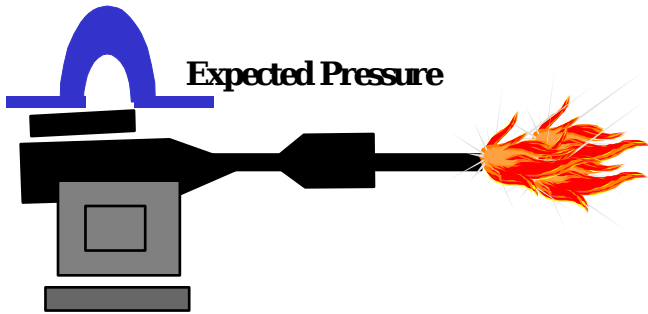


“New” (Tight Fitting) Gun

High Velocity

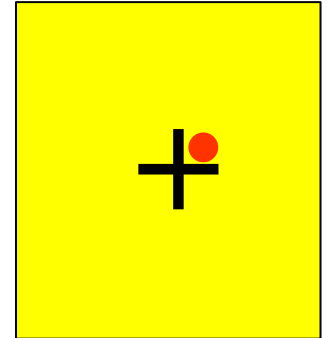


Hits Above Target

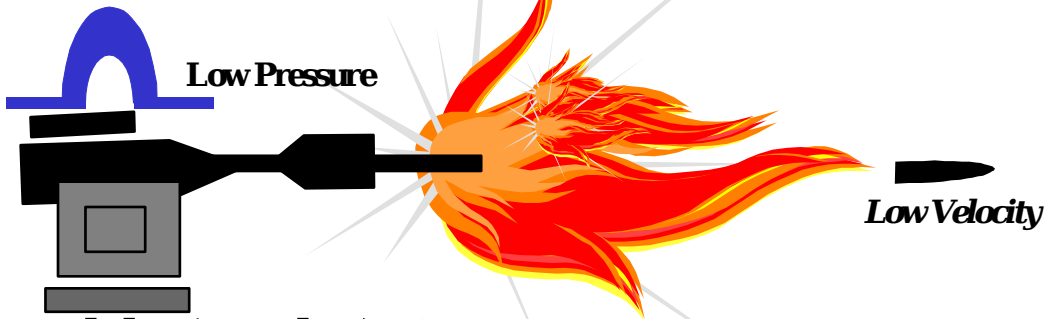


“Standard” Gun

Expected Velocity

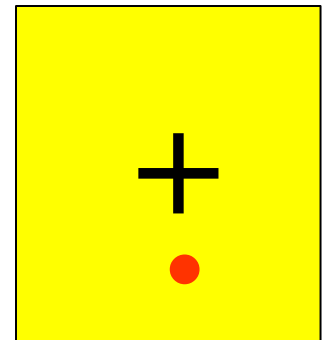


Hits On Target



“Old” (Leaky) Gun

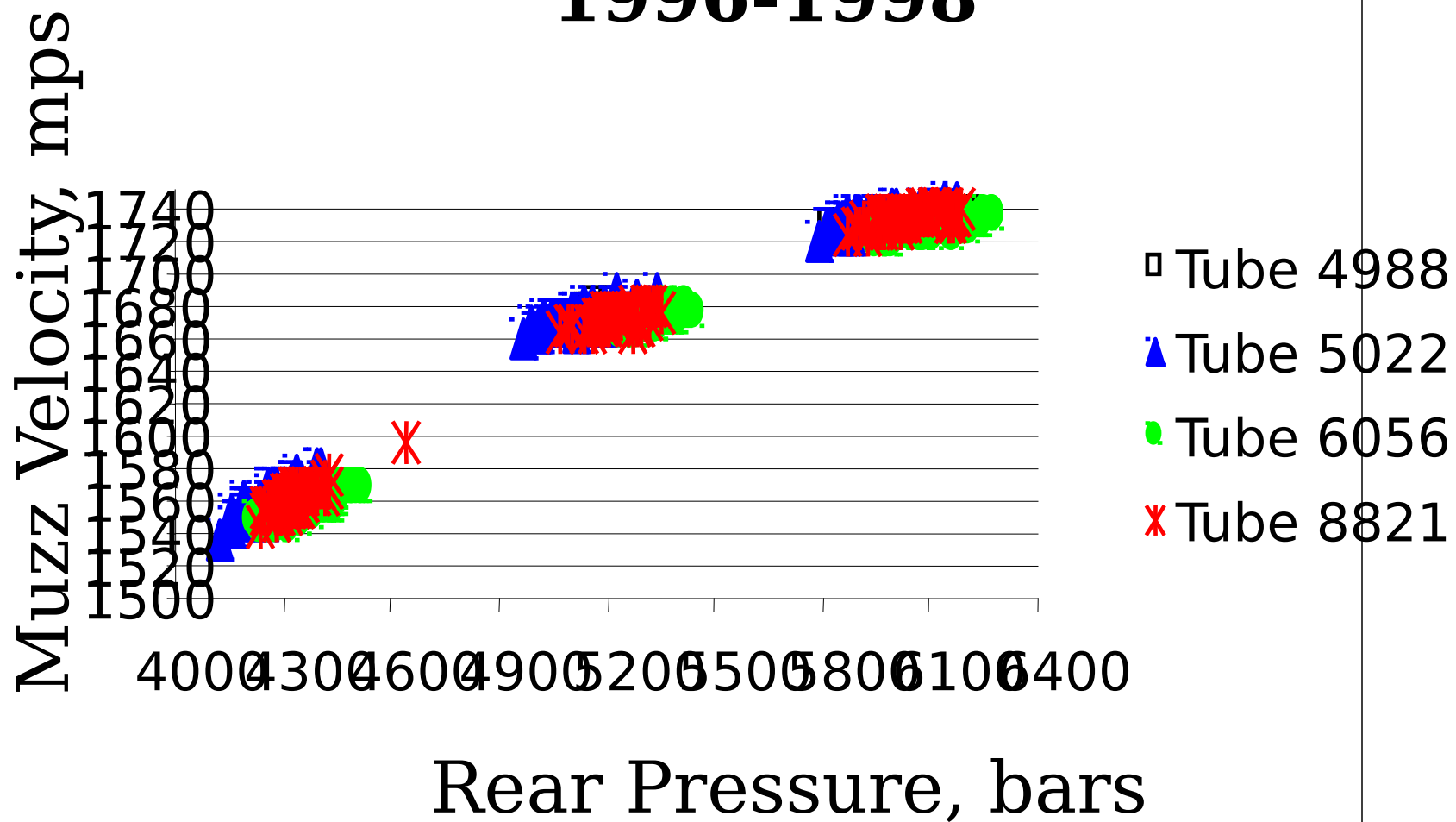
Low Velocity



Hits Below Target

CONTROL RDS: ALL TEMPERATURE

1996-1998



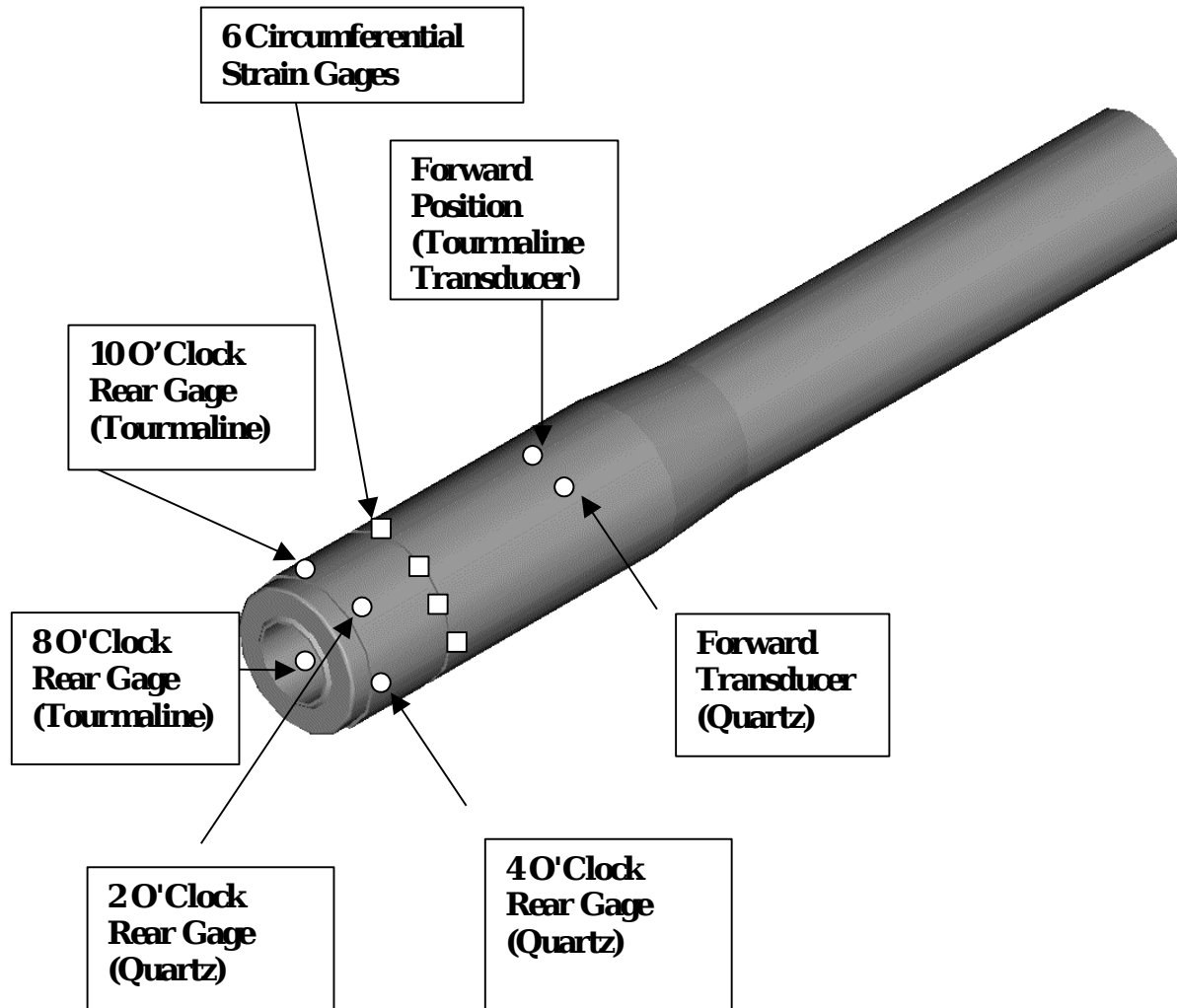
Unusually Consistent Ammunition

Lots

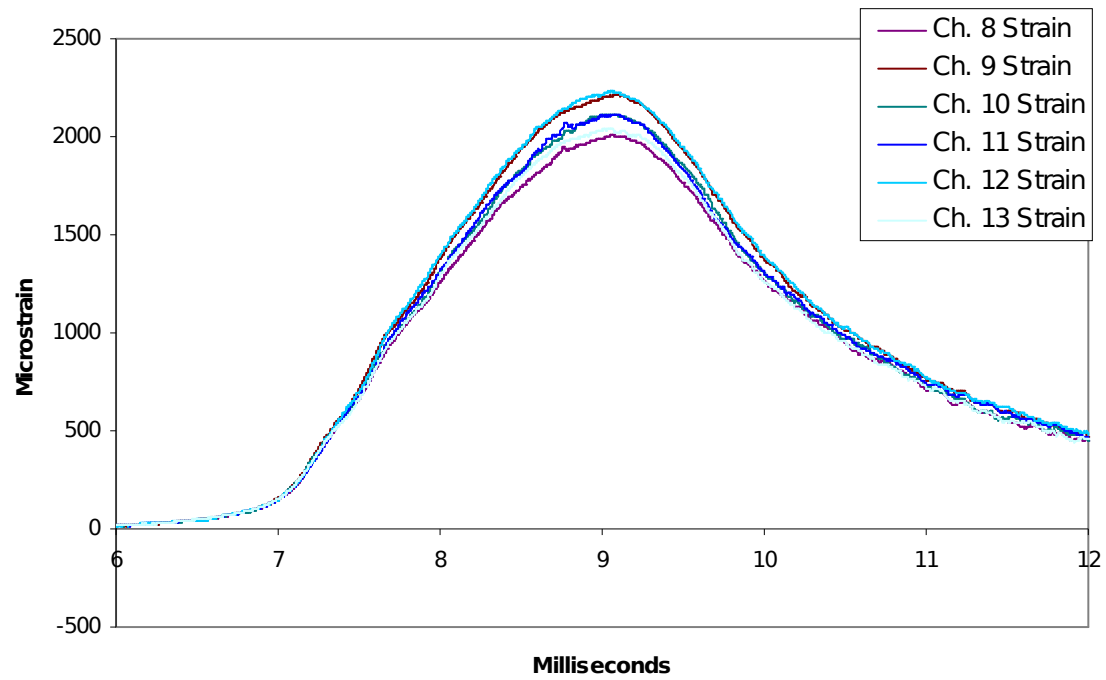
1995-1998

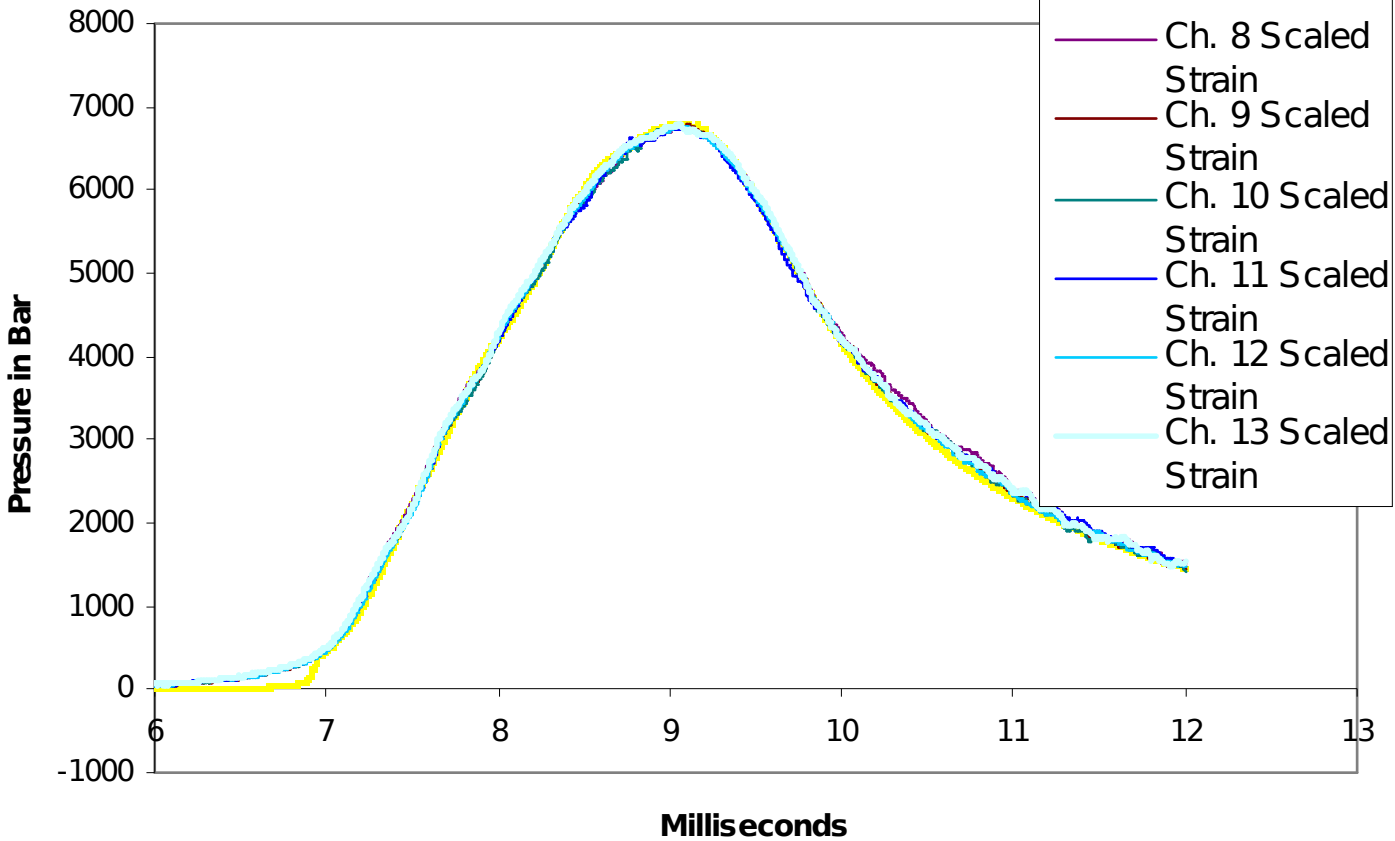
Data

Tube	Pressure	Velocity	N
8821	5223.36	1671.434	45
6056	5349.32	1670.488	25
5022	5150.75	1671.505	77
4988	5215	1670.513	24
Mean	5234.608	1670.985	
Std. Dev.	83.07025	0.560496	
Gage	Pressure	Velocity	N
275	5311.167	1669.7	6
305	5198.333	1671.908	12
304	5152.167	1668.533	6
Mean	5220.556	1670.047	
Std. Dev.	81.79621	1.714082	

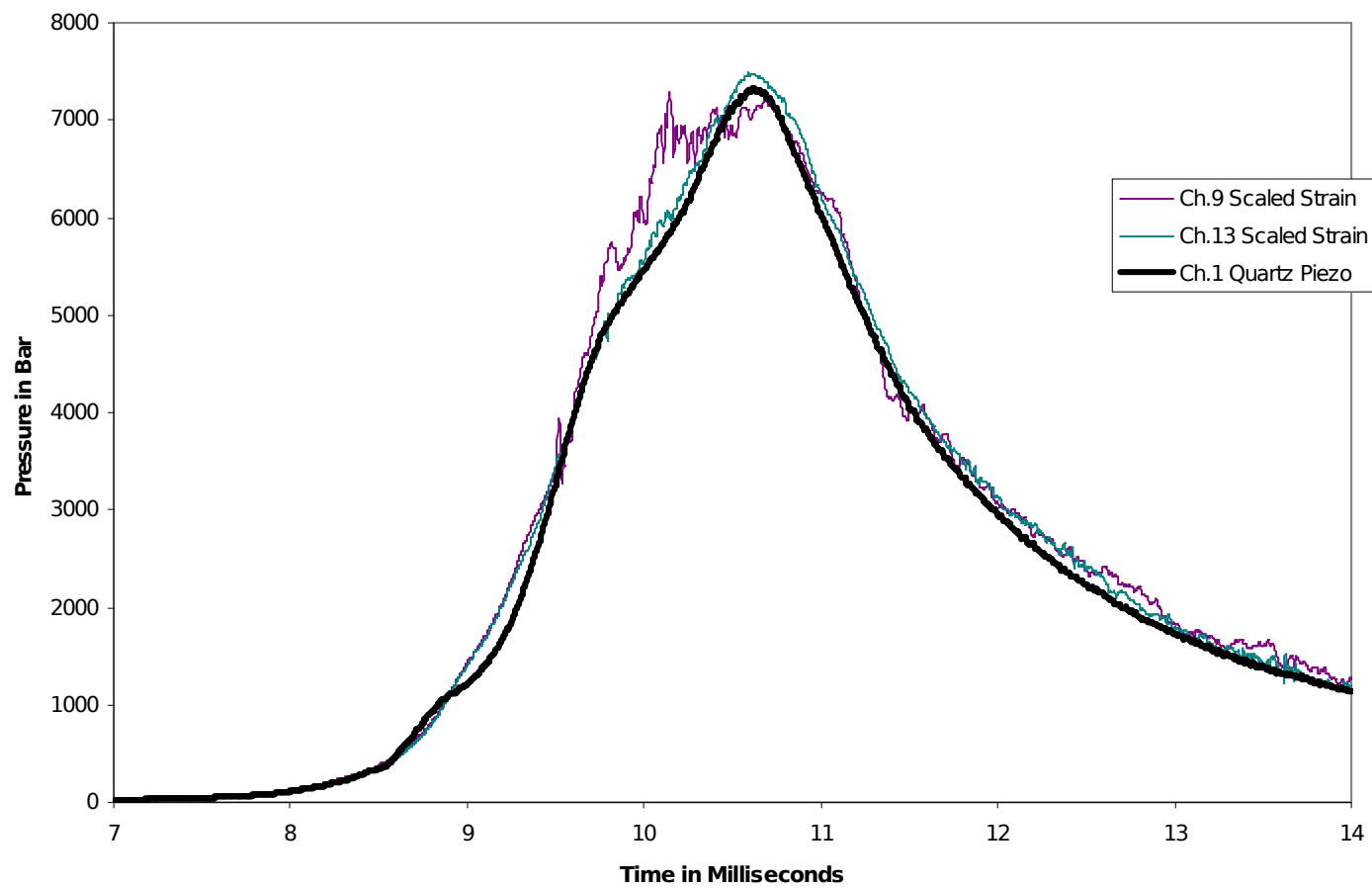


Rd. 6, Fired 7 Feb 02



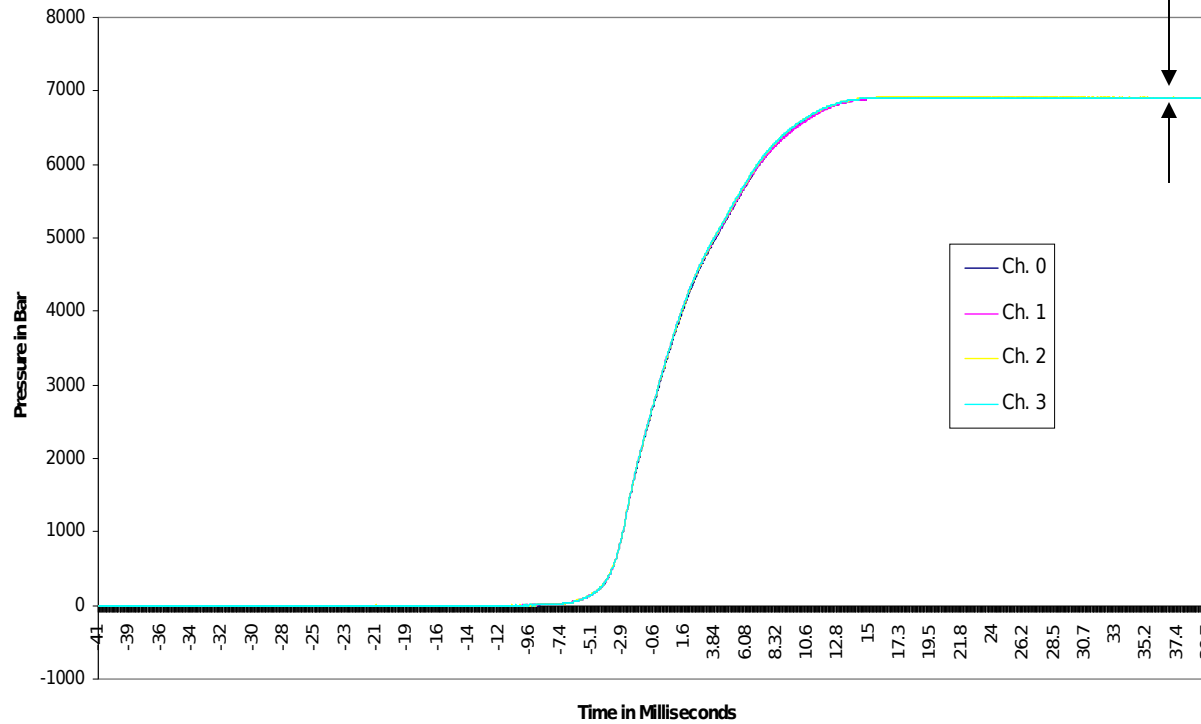
Rd. 6 7 Feb 02

Round 13, 26Mar02, Severe Pressure Waves



Laboratory Static Pressure Test PH11

**0.5%
Discrepancy**



Laboratory Static Pressure Test of Transducers PH10

1.9%
Discrepancy

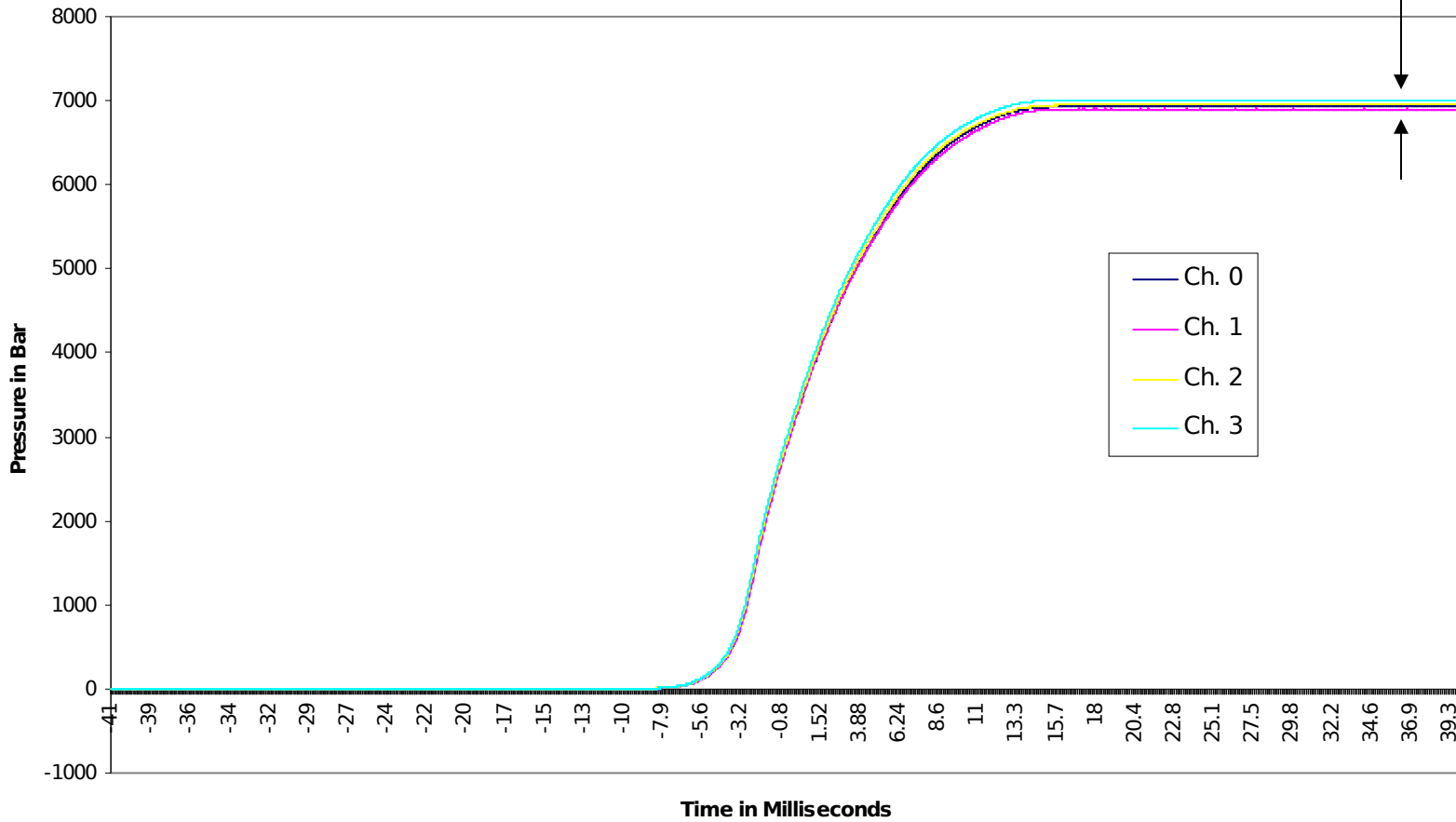
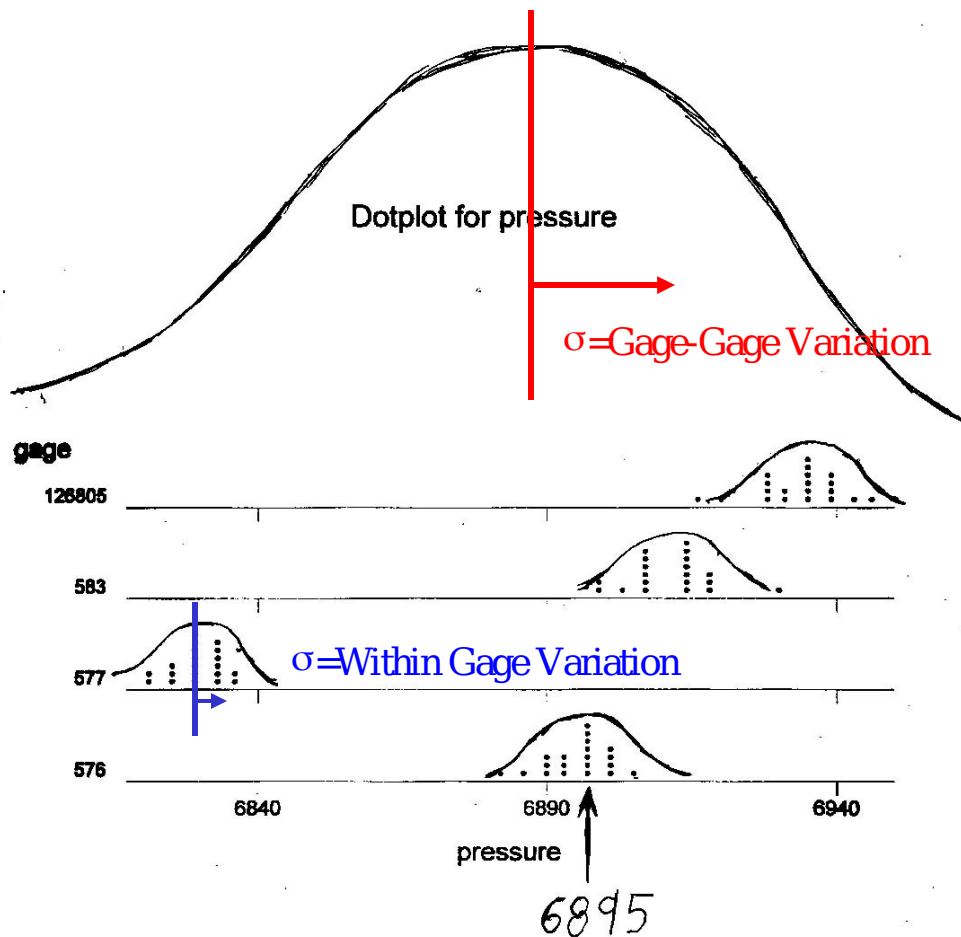
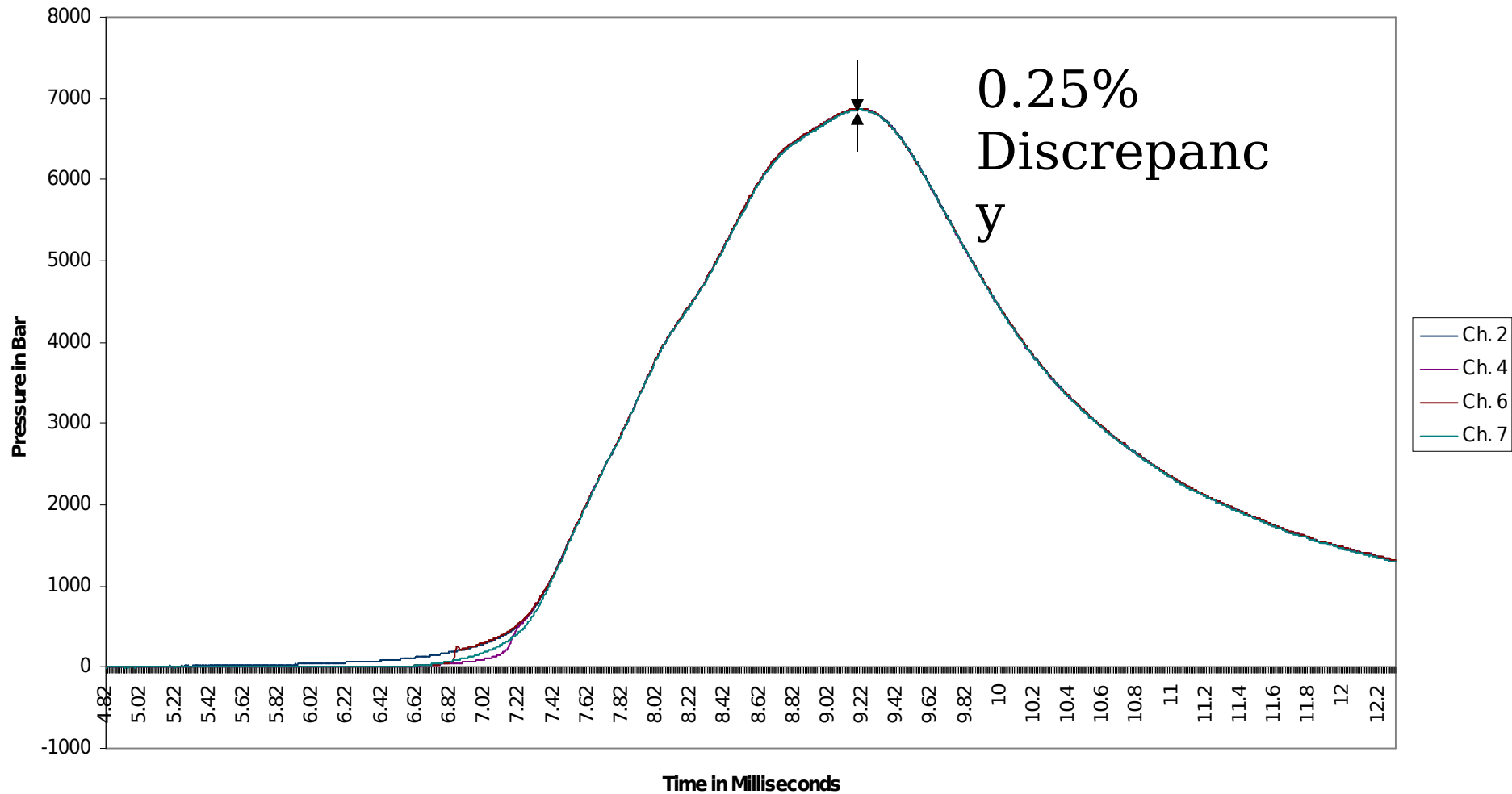


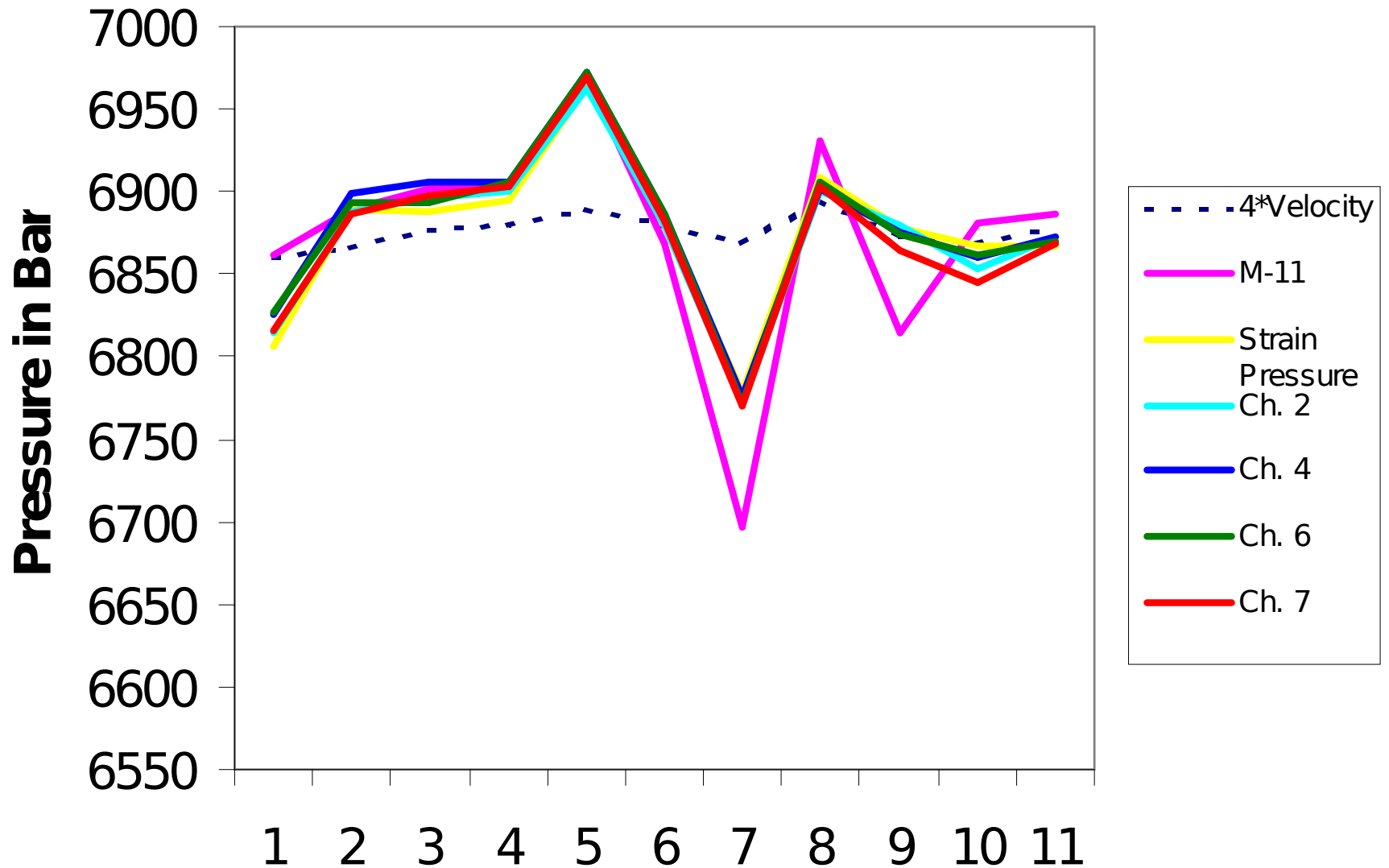
ILLUSTRATION OF GAGE-GAGE AND WITHIN-GAGE VARIATION IN STATIC PRESSURE LABORATORY TESTING



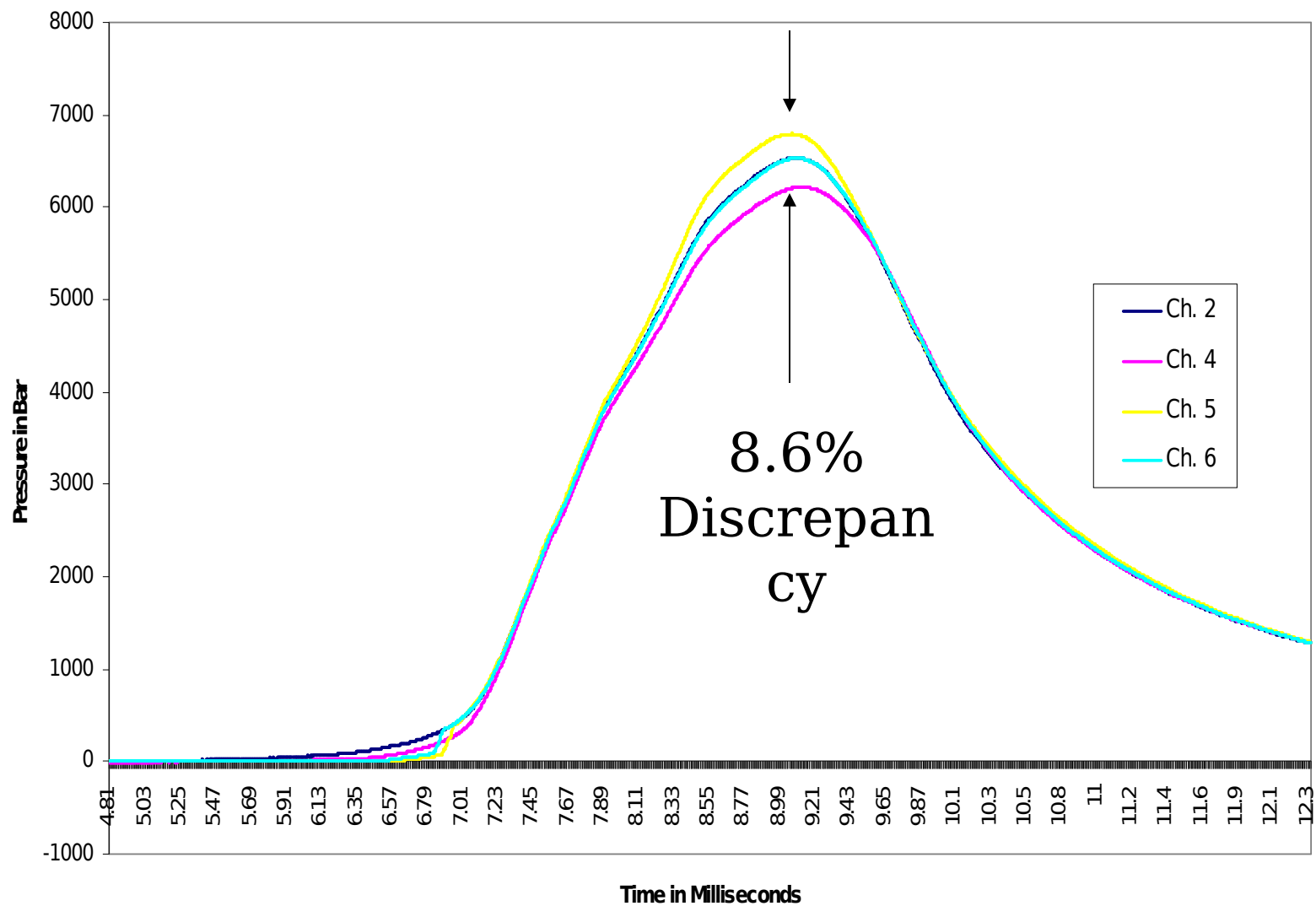
120mm Field Test Rd. 34, 11 Feb 02



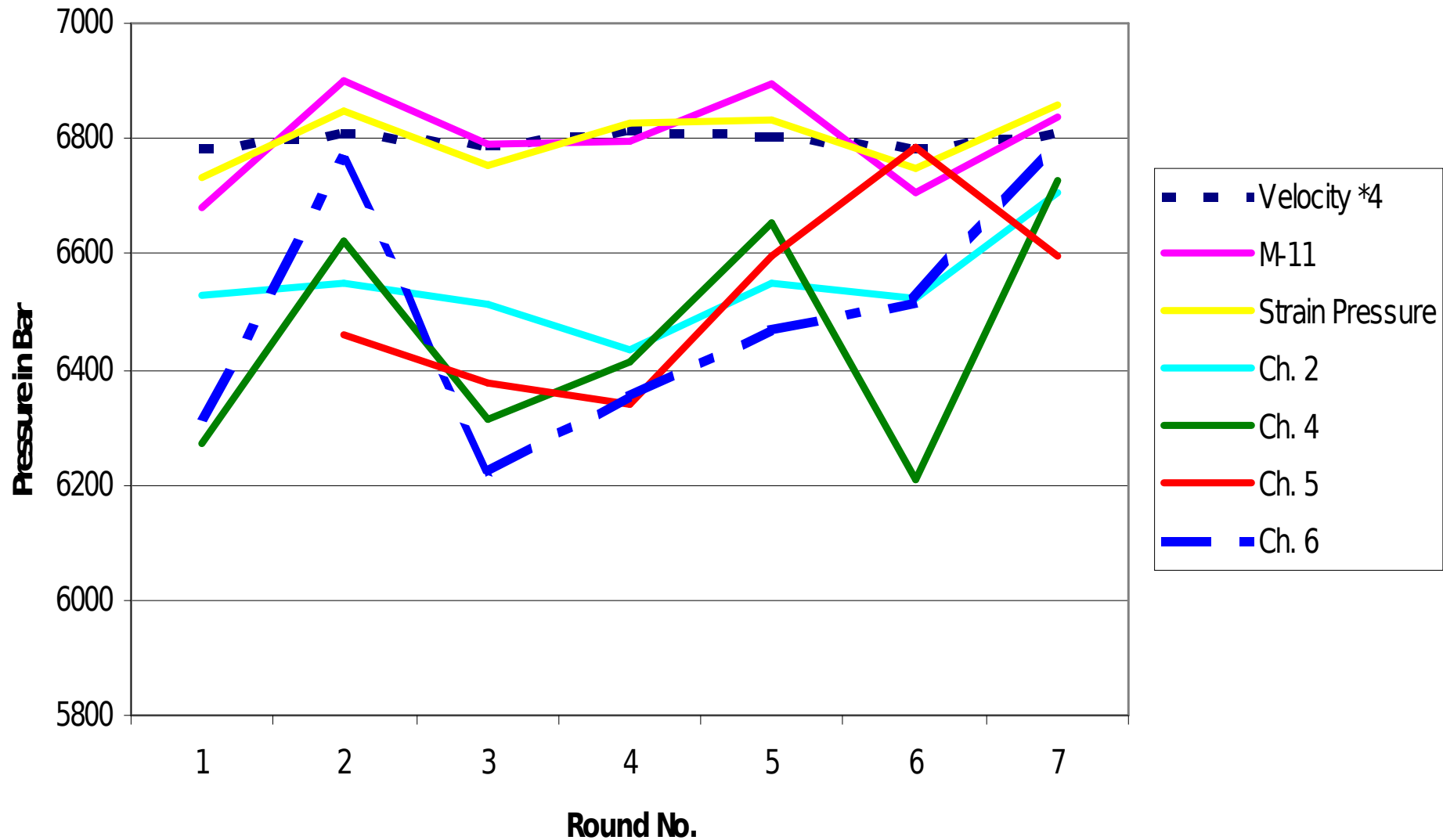
120mm Field Test Rounds 25-35



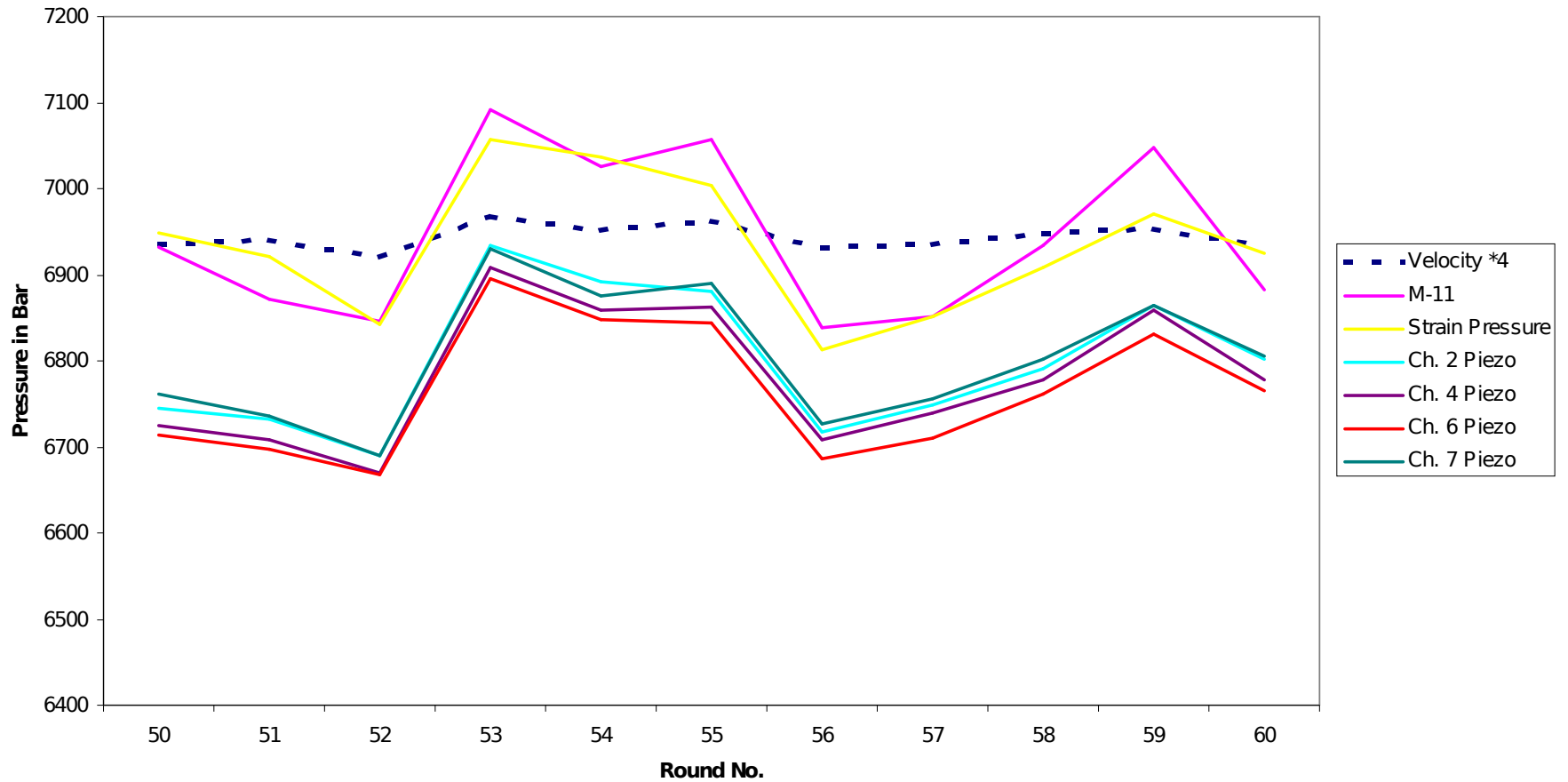
Field Measurement in 120mm Gun



Comparison of M-11, Copper Crusher, Velocity, and Piezo Gage Data for Rounds 1 - 7, 7 Feb 02



120mm Field Test Rounds 50-60



CONCLUSIONS

- BETTER CHAMBER PRESSURE TRANSDUCERS ARE NEEDED
- USE OF CRUSHER, PIEZO, STRAIN, AND VELOCITY MEASUREMENTS IMPROVES ACCURACY
- ON 'GOOD DAYS', ALL MEASUREMENTS AGREE
- ON 'BAD DAYS', THE PROBLEM MEASUREMENTS CAN BE IDENTIFIED

